



***Preliminary PM<sub>2.5</sub> Exceptional Event Analysis***

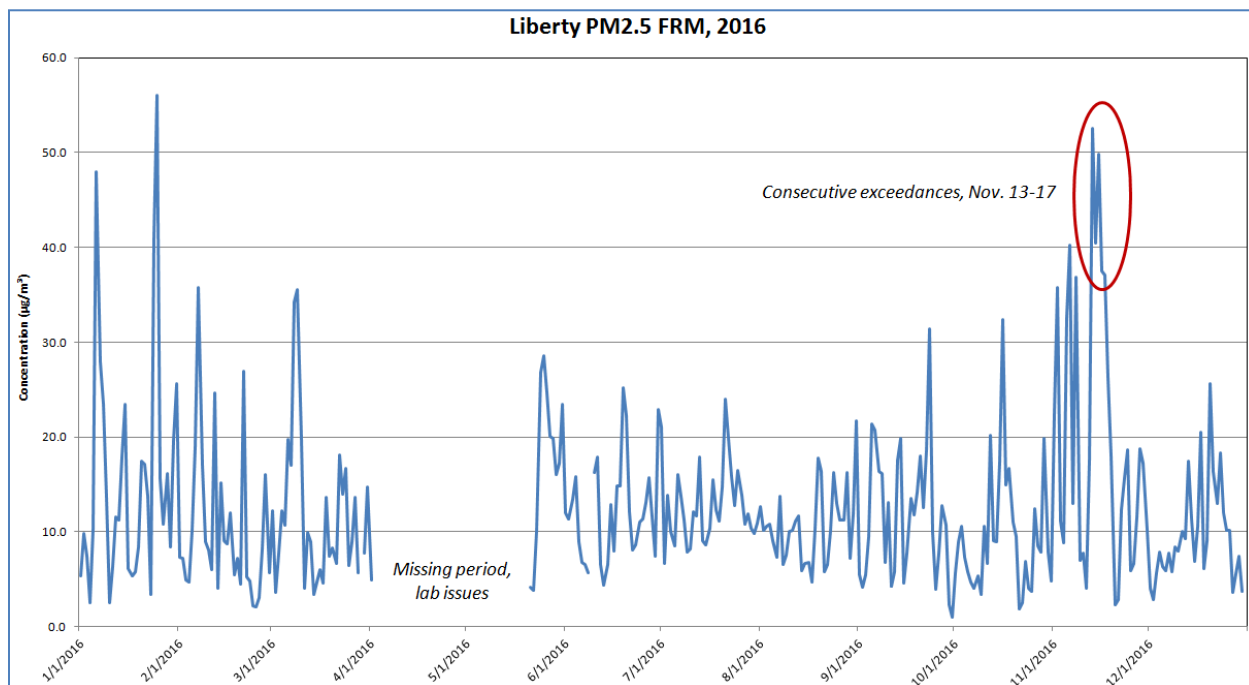
**November 2016 PM<sub>2.5</sub> Data**

**Allegheny County Health Department  
Air Quality Program**

***DRAFT***  
**August 2017**

## Monitored Results


Below are the daily PM<sub>2.5</sub> FRM (1-in-1) results for Liberty in 2016. The November data showed 8 exceedances of the 35 µg/m<sup>3</sup> 24-hour standard, including 5 consecutive days during November 13-17. While the magnitude of the exceedances was not the highest measured during the year (compare to Jan. 25<sup>th</sup>), the number of the exceedances were anomalous for one single month of data for Liberty.



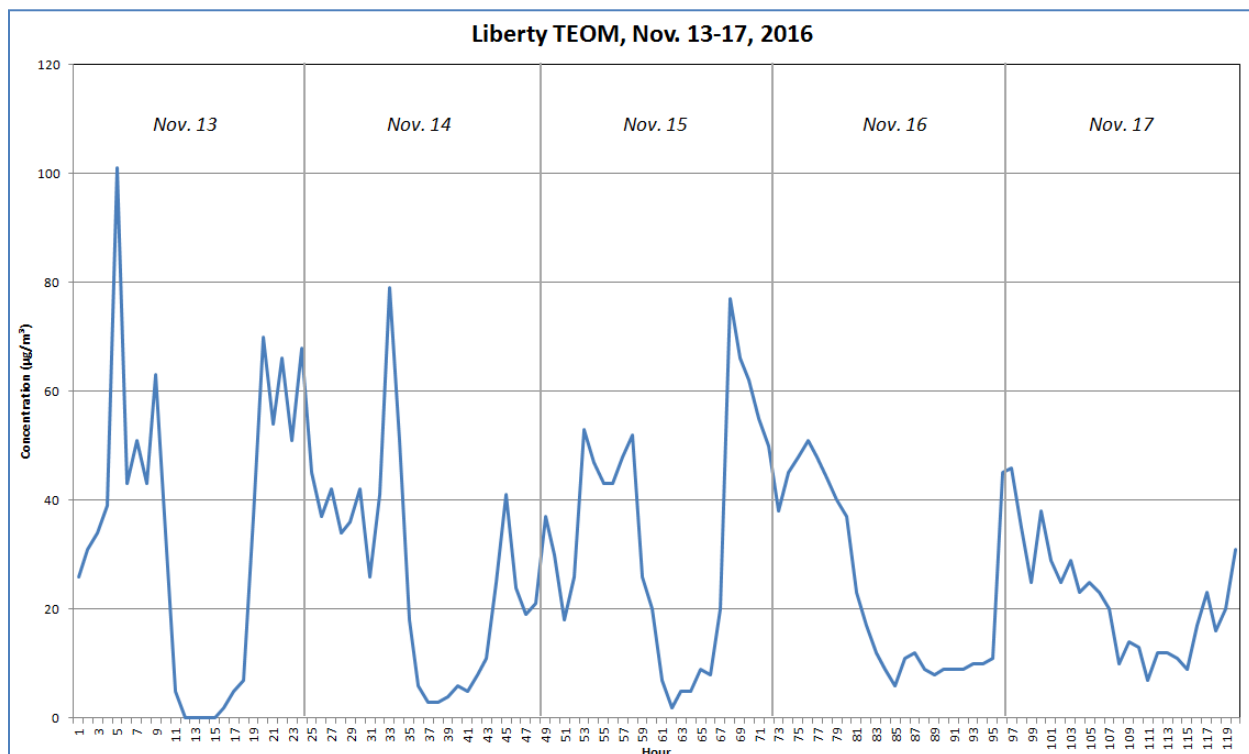
Below are the monitored concentrations during the 5-day period. Based on source apportionment, meteorological analyses, etc., the Liberty monitor is affected by several different components for PM<sub>2.5</sub>. This includes local source influences under inversion conditions, as well as regional components such as upwind transport from power plants. All of Allegheny County can also be affected by regional events, such as stagnant high pressure systems, persistent wildfires, etc.

It is presumed that local source influences were the primary contributors to most of the exceedances in 2016, including those during the 5 consecutive exceedances. Below are the Liberty PM<sub>2.5</sub> concentrations during the 5-day timeframe. The concentrations on Nov. 13<sup>th</sup> and 15<sup>th</sup> are more than 10 µg/m<sup>3</sup> over the NAAQS and would have likely exceeded with/without any regional events. The concentrations on Nov. 14<sup>th</sup>, 16<sup>th</sup>, and 17<sup>th</sup>, being closer to the NAAQS, could have included regional contributions that led to 2-5 µg/m<sup>3</sup> over the NAAQS.

Date	Liberty FRM (µg/m <sup>3</sup> )
11/13/2016	52.5
<b>11/14/2016</b>	<b>40.4</b>
11/15/2016	49.8
11/16/2016	37.5
11/17/2016	37.1

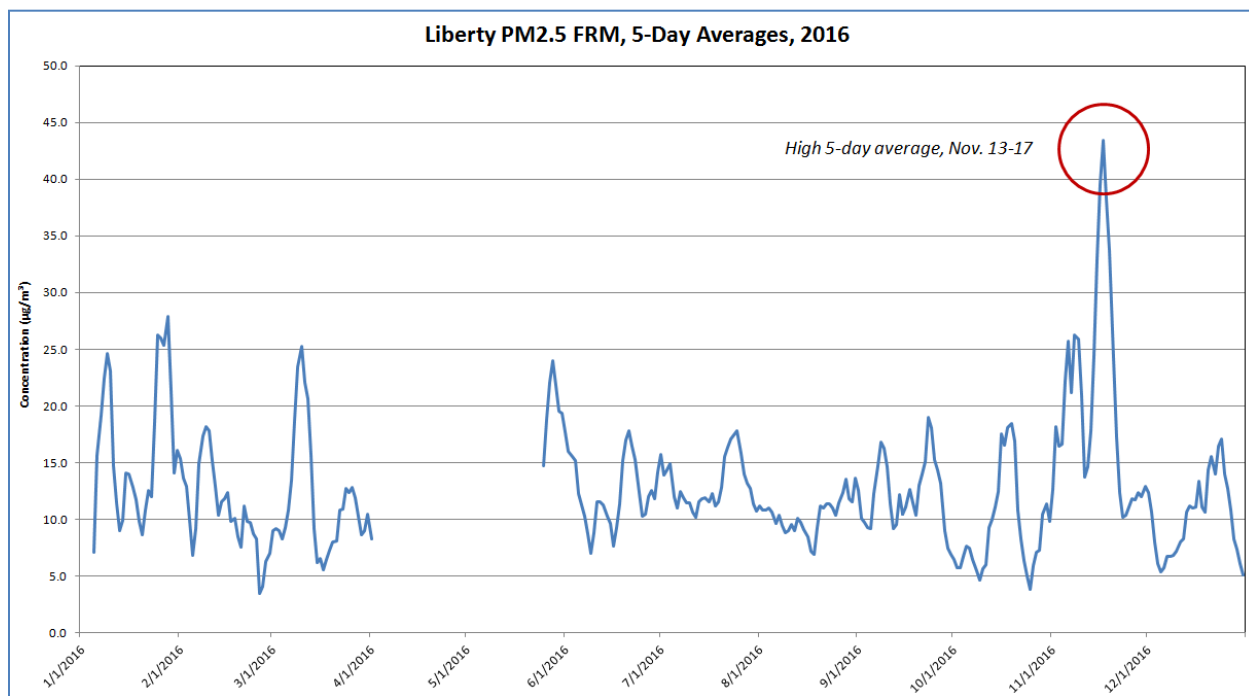
However, the concentrations on Nov. 16<sup>th</sup> and 17<sup>th</sup> would not affect the final 98<sup>th</sup> percentile for 2016. (Note that the missing period in April/May results in the 7<sup>th</sup>-high 24-hour concentration as the 98<sup>th</sup> percentile.) Therefore, this analysis looks at the possibility that Appalachian wildfires occurring over this timeframe may have adversely affected the Liberty monitor concentration on Nov. 14<sup>th</sup> (shown in bold above), causing an exceedance that was unpreventable at the site. 

Below is a look at the hourly concentrations during the 5-day timeframe. Concentrations followed the general diurnal pattern of high-to-low during nighttime inversion conditions, with lower concentrations during the break in the inversion during the day. Daytime concentrations were in the range of 3-8 µg/m<sup>3</sup> on Nov. 14<sup>th</sup>, indicating the range of the regional or background component at the site. The daytime component was higher on the next 3 days, possibly as a result of continued regional contributions.

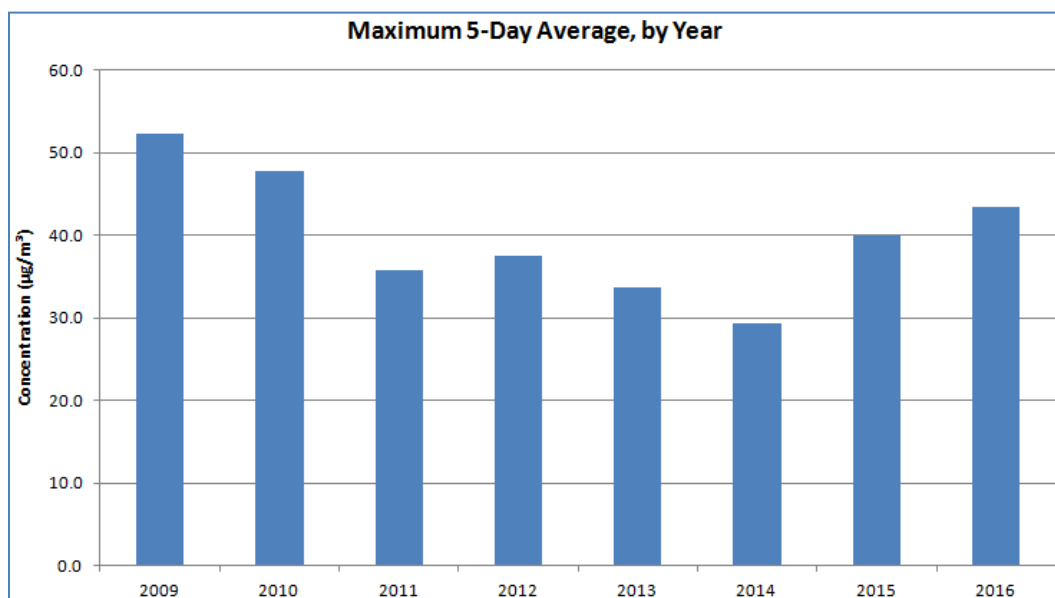






As mentioned earlier, the exceedances occurred during a 5-day period that was anomalous, at least for recent PM<sub>2.5</sub> data (the past 5 years). Below is a chart of the 5-day averages throughout 2016.

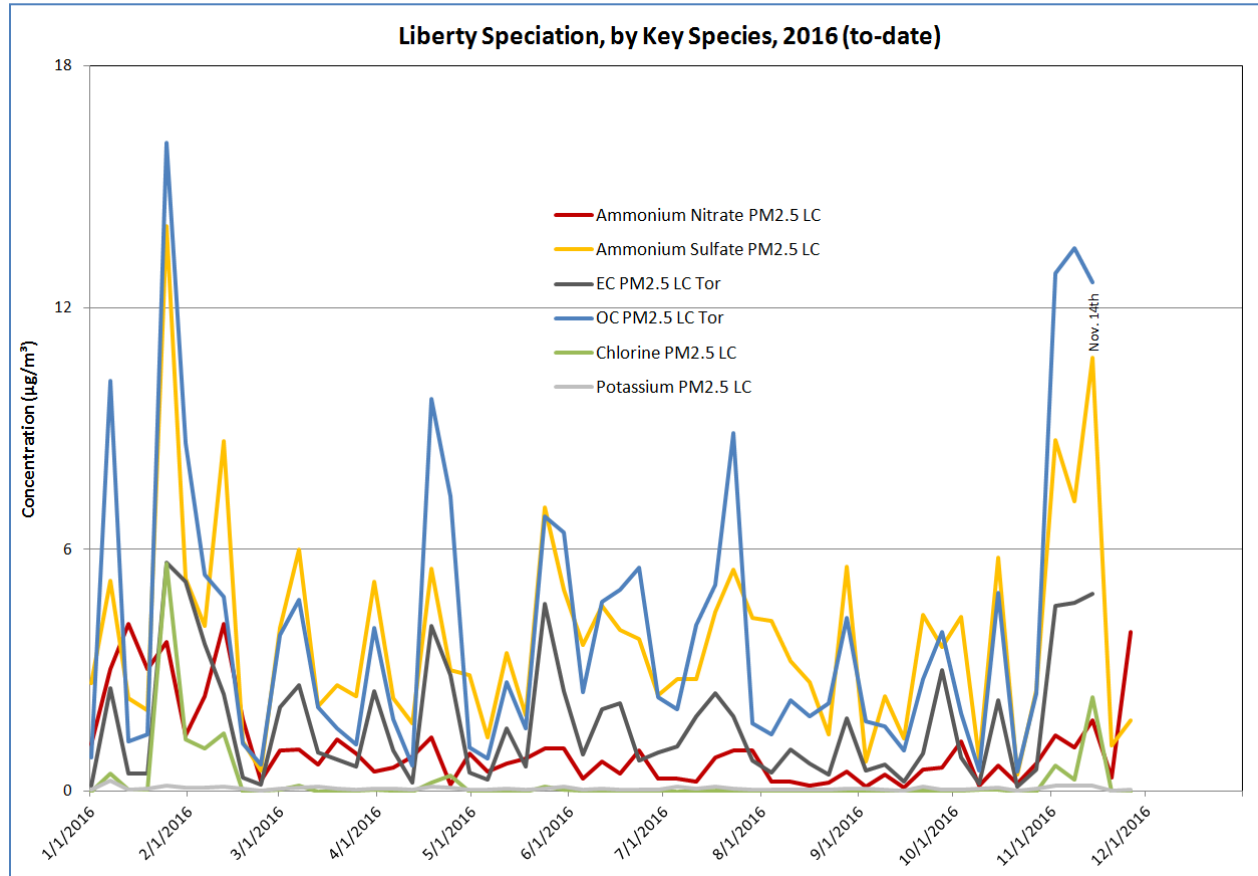


Compared to previous years (below), 2016 showed the highest 5-day average over the past 5 years. The maximum 5-day averages in 2009-2010 were higher than 2016, but these years featured considerably higher upwind power plant emissions as well as higher localized emissions, before implementation of SIP controls for the 2006 NAAQS. The Liberty monitor has been in attainment of the 2006 NAAQS since 2014.

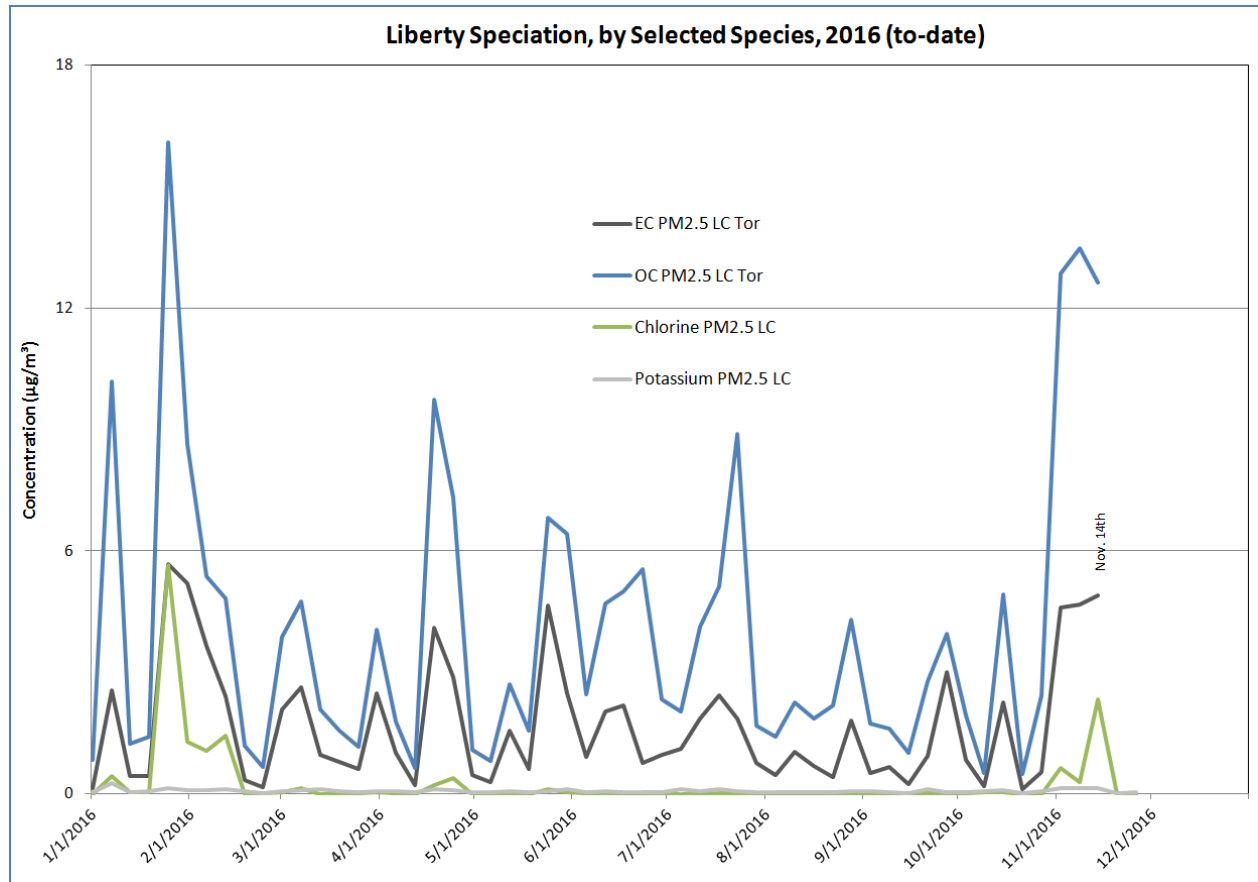


Below is a look at the 2016 CSN speciation (1-in-6) data for Liberty 2016, shown by key species. Liberty generally shows an excess of carbons and specific trace elements such as chlorine. Ammonium sulfate is usually a regional component of PM<sub>2.5</sub> for Allegheny County, but Liberty can also show a localized fraction. Potassium is included on this chart as a possible indicator of burning. 

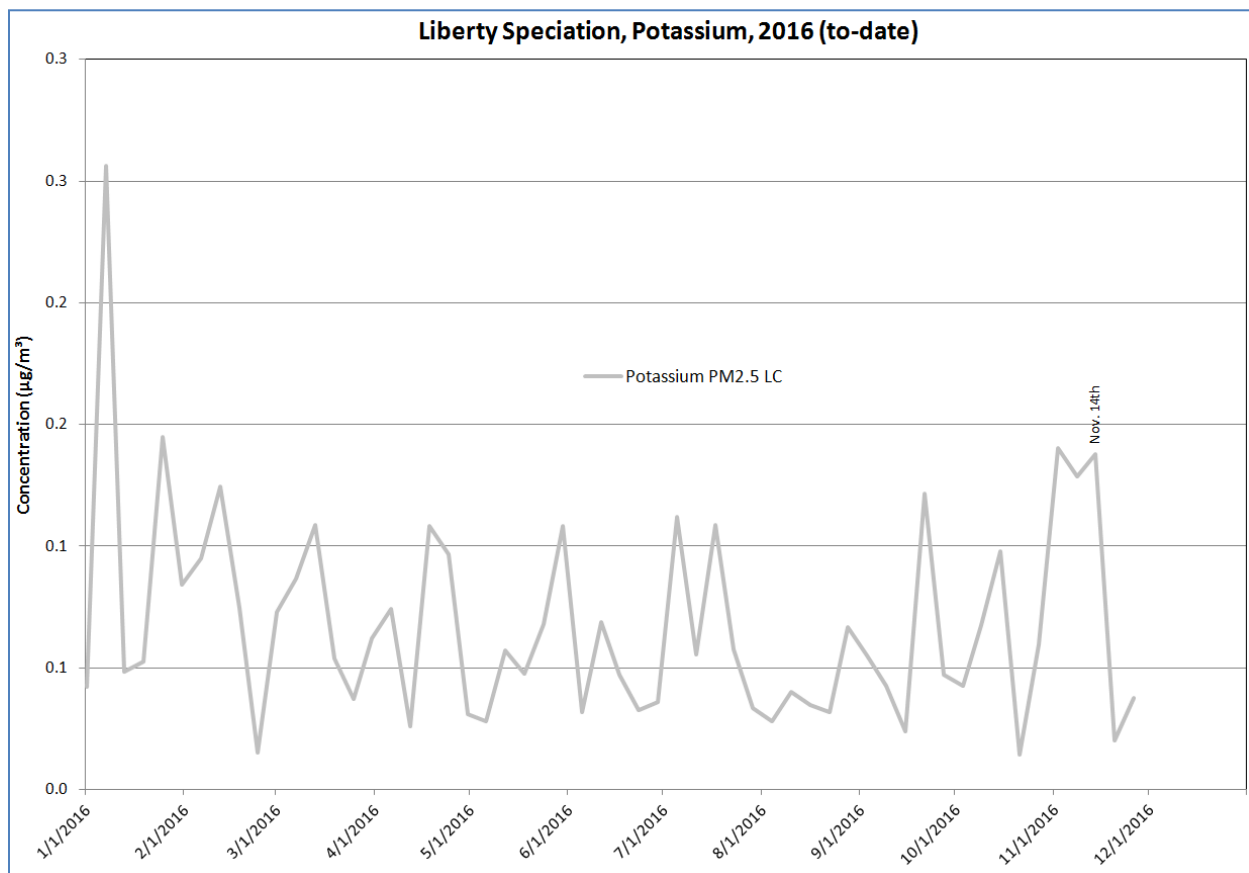
Only Nov. 14<sup>th</sup> (indicated on the chart) is available during the 5-day exceedance period in Nov. 2016. The CSN results showed high organic and elemental carbon fractions, along with a chlorine peak. These species are usually indicative of local industrial sources, but a portion of the carbons may be due to wildfire influences. 



The 2016 chart is repeated below, showing only on carbons and elements. The correlation of carbons with chlorine during cold months is unique to the Liberty site. Potassium concentrations are too low in comparison to other species on this chart.






For a better look at potassium, 2016 data is shown below with an adjusted y-axis (all other species are not shown). On the Nov. 14<sup>th</sup> date, potassium was somewhat elevated (along with November in general), but not atypically high. The highest potassium concentration was in fact in January. This can be due to local burning for wintertime heating, which is normally associated with wind directions to the east (see meteorology discussion below).





## Exceptional Event Rule Elements

Below are elements used to determine an exceptional event. All of the  would apply to the Liberty November 2016 data. However, the “no exceedance but for the event”  cannot be determined precisely in this case, since there is no exact method of apportioning regional and local components for PM<sub>2.5</sub> at Liberty. Based on data provided in this document, there may be evidence that wildfires contributed a range of concentrations that may have led to an exceedance on Nov. 14<sup>th</sup>. 

Affects Air Quality
Not Reasonably Controllable or Preventable
Caused by Human Activity Unlikely to Reoccur at a Particular Location or Natural Event
Clear Causal Relationship Between Measurement and Event
No Exceedance or Violation But For the Event
The Event Is Associated with Measured Concentration In Excess of Normal Historical Fluctuations, Including Background



## Meteorology

Below are the hourly wind direction and speed along with temperature for Liberty (local standard time). Most hours featured directions from the south/southwest, with low/moderate wind speeds.

Date/Hour	Wind Dir (deg)	Wind Speed (mph)	Outside Temp (°C)
11/14/2016 0:00	136	2.6	0.3
11/14/2016 1:00	170	1.7	0.0
11/14/2016 2:00	208	2.5	-0.6
11/14/2016 3:00	157	2.6	-1.2
11/14/2016 4:00	204	3.5	-1.8
11/14/2016 5:00	76	1.3	-1.7
11/14/2016 6:00	86	1.3	-1.9
11/14/2016 7:00	188	1.7	-2.1
11/14/2016 8:00	198	2.0	0.5
11/14/2016 9:00	198	2.1	5.1
11/14/2016 10:00	203	3.5	8.4
11/14/2016 11:00	189	4.0	11.2
11/14/2016 12:00	239	2.8	13.6
11/14/2016 13:00	174	5.2	13.5
11/14/2016 14:00	169	5.9	13.4
11/14/2016 15:00	182	6.1	12.8
11/14/2016 16:00	196	2.7	11.8
11/14/2016 17:00	246	1.8	11.0
11/14/2016 18:00	216	3.4	10.0
11/14/2016 19:00	215	2.7	8.8
11/14/2016 20:00	203	3.6	7.2
11/14/2016 21:00	202	3.0	6.7
11/14/2016 22:00	196	3.8	5.7
11/14/2016 23:00	179	2.6	5.1




Below are inversion statistics for November 2016, for both morning and evening data. Inversions occurred during the 5 consecutive exceedances in Nov. 13-17<sup>th</sup>, along with several other days. (Nov. 14<sup>th</sup> data is in bold.) November experienced an atypically high number of inversions compared to historical data. Once trapped in river valleys, air is not easily dispersed during persistent inversion conditions.

### INVERSION STATISTICS\* for Nov. 2016

Derived from PIT NWS\*\* SOUNDINGS

#### 7 AM (morning)


Nov. 2016	Strength (°C)	Depth (m)	Est. Brk. Time (EST)	
1	9.4	263	12.0	
2	3.2	351	9.0	
5	4.6	212	9.5	
6	5.4	428	12.0	
7	7.8	444	11.5	
8	11.0	233	12.0	
10	3.8	235	10.0	
12	2.5	123	9.0	
13	7.1	860	16.0	
<b>14</b>	<b>8.3</b>	<b>178</b>	<b>10.5</b>	
15	5.4	238	11.0	
16	2.4	279	12.0	
17	4.6	170	10.5	
18	11.8	229	11.5	
19	3.0	305	9.0	
22	1.6	203	9.5	
23	9.1	970	16.0	
24	1.2	414	10.0	
28	9.0	163	15.0	
29	1.8	301	11.0	
30	1.8	247	8.0	% of Days
Avg.	5.5	326	11.0	70
Nov. Avg. '09-'15	4.5	258	11.0	44

\* For morning surface inversions of at least 1.0°C in strength (shallow isothermal and/or unstable conditions may also be present below or within surface inversion). Estimated Break Time to nearest 0.5 hr EST.

\*\* PIT NWS = Pittsburgh National Weather Service.

**INVERSION STATISTICS\* for Nov. 2016**  
**Derived from PIT NWS\*\* SOUNDINGS**

**7 PM (evening)**

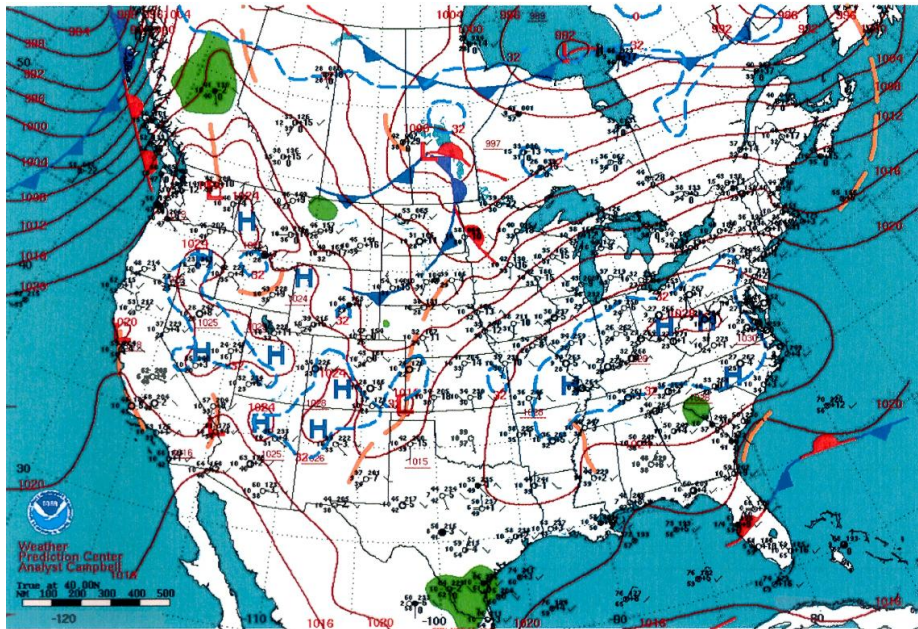
Nov. 2016	Strength (°C)	Depth (m)	
1	0.6	98	
2	1.0	71	
4	1.4	51	
5	0.8	112	
6	1.2	26	
7	1.8	43	
12	0.8	67	
13	1.6	95	
<b>14</b>	<b>0.4</b>	<b>103</b>	
15	1.0	43	
17	1.0	104	
18	1.2	63	
22	1.1	90	
23	2.6	376	
27	0.4	110	
28	2.6	216	
29	1.0	141	
<b>Avg.</b>	1.2	106	<b>% of Days</b> 57

\* For evening surface inversions of at least 0.4°C in strength (shallow isothermal and/or unstable conditions may also be present below or within surface inversion).

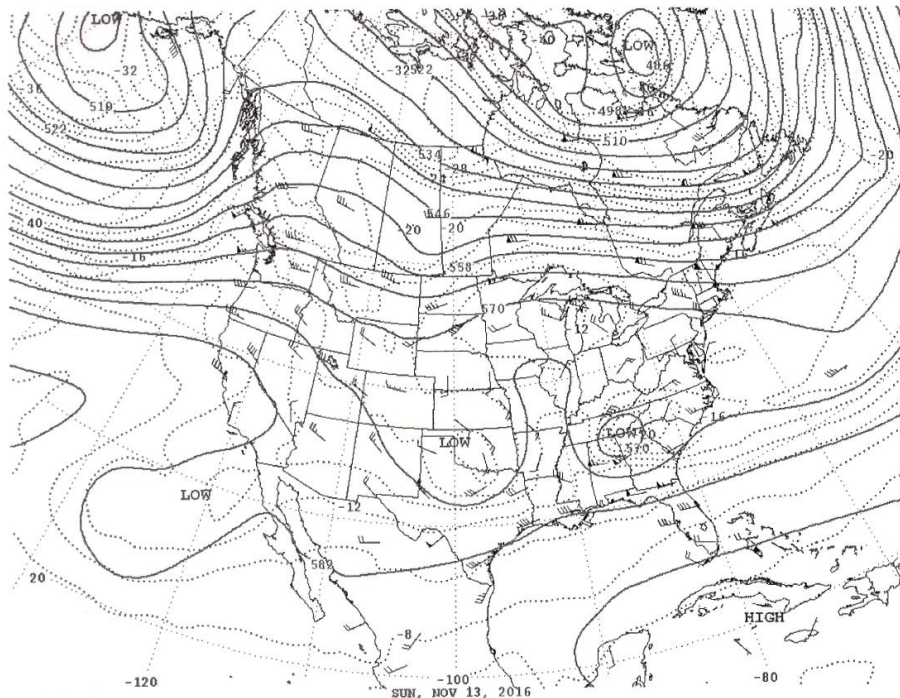
\*\* PIT NWS = Pittsburgh National Weather Service.

Below are surface and 500-mb weather maps for Nov. 13-14<sup>th</sup>, 2016 (a 48-hour period leading up to and during Nov. 14<sup>th</sup>). Rather stagnant weather conditions persisted in southwestern Pennsylvania during the 5-day period of elevated data at Liberty. High pressure settled in over the eastern portion of the U.S. with its attendant light winds and ground-level temperature inversions. Afternoon ventilation rates were estimated to go from poor to only fair during the period with transport winds from the southwest then west.

### November 13<sup>th</sup>



Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

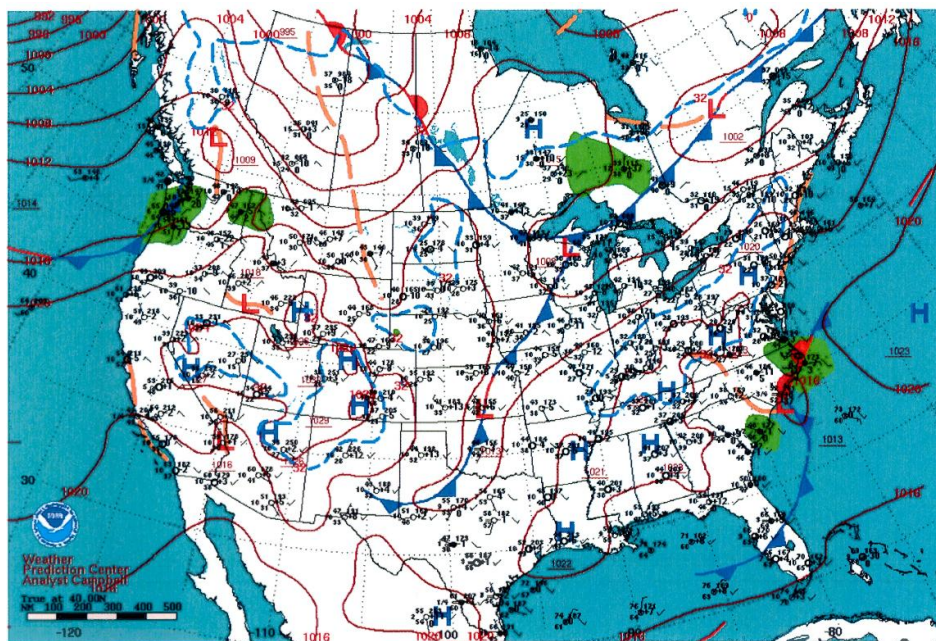


500-Millibar Height Contours at 7:00 A.M. E.S.T.

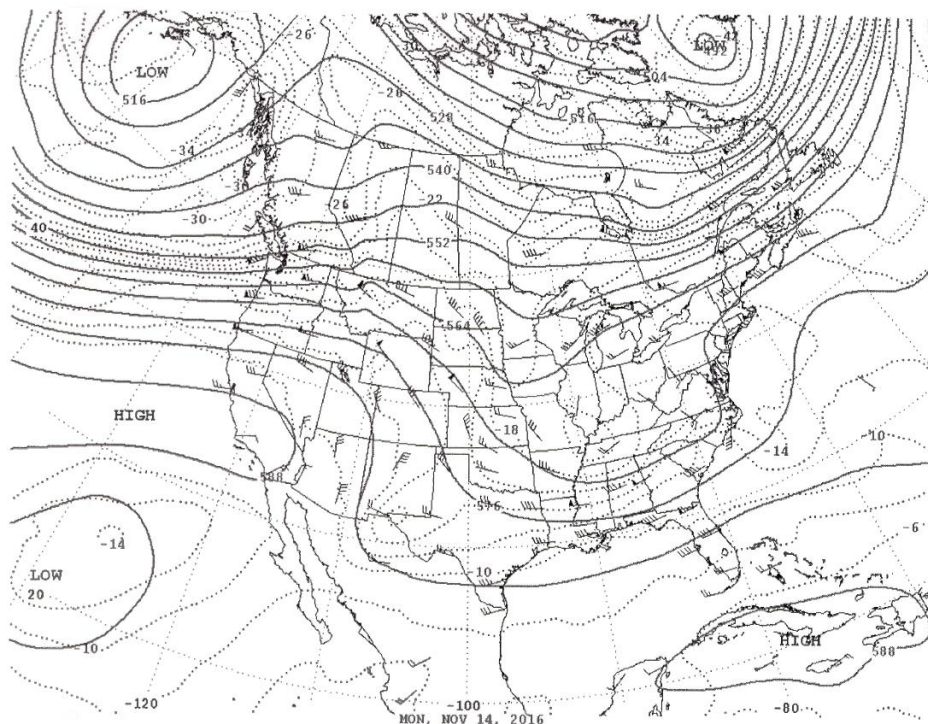




November 14<sup>th</sup>



Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



500-Millibar Height Contours at 7:00 A.M. E.S.T.

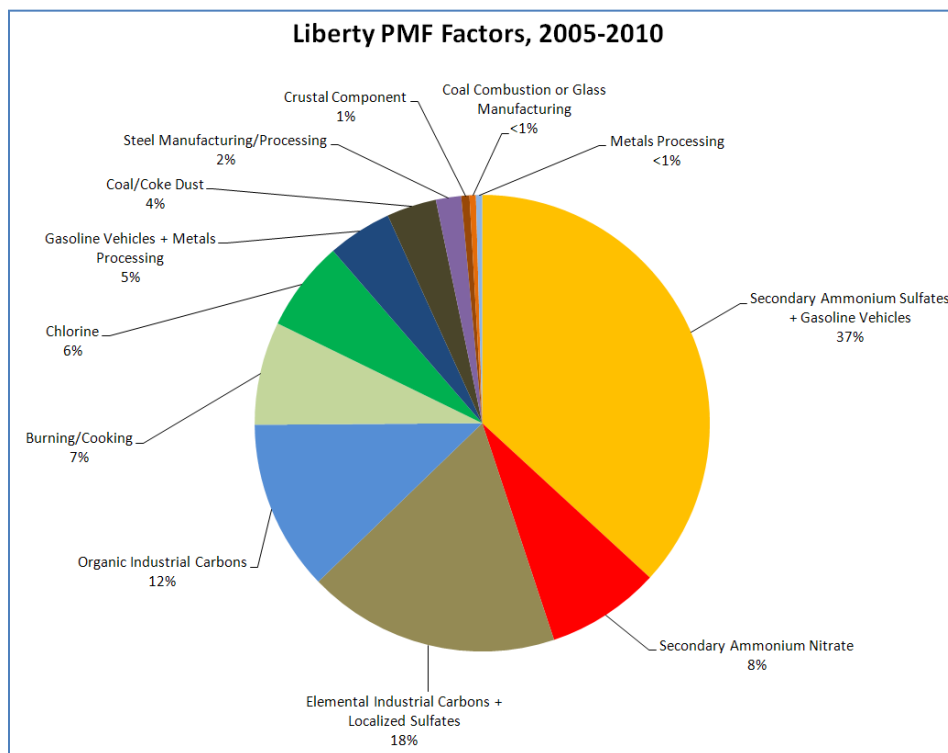


## Source Apportionment

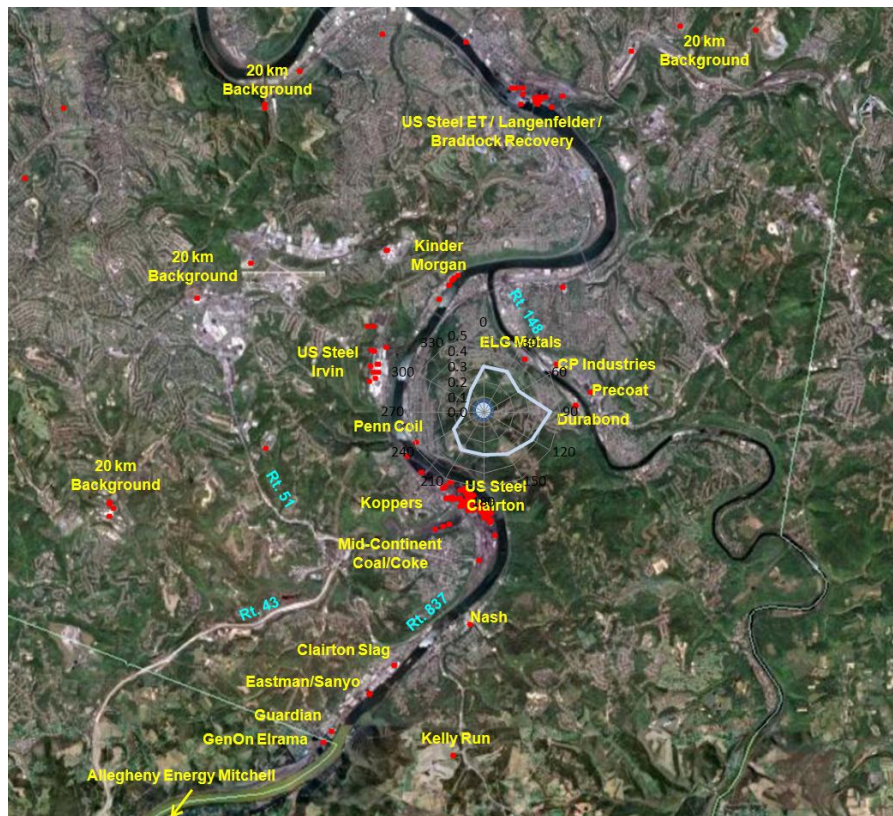
[Note: PMF Analysis is being updated for more recent years.




PMF source apportionment results show that Liberty can show a considerable amount of contributions from burning. In the case of the below pie chart, this is primarily due to local burning from the residential community of Liberty to the east of the site.



Below, the directional Conditional Probability Function (CPF) plot from 2005-2010 source apportionment results for the Liberty burning component shows that the wind directions are predominantly from the east when this factor is high.




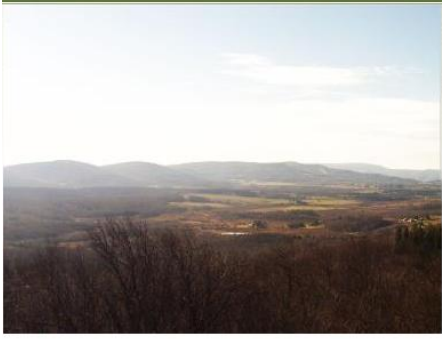

Since directions were primarily from the south/southwest on Nov. 14<sup>th</sup>, localized burning was probably not a large contributor to concentrations. 



## HazeCams

Below are images from Dolly Sods, the nearest Class I area to Pittsburgh, PA. The hazecam archives 3 images per day: at 9 AM, noon, and 3 PM (EST).


US Forest Service
Air Quality Images







Pristine Conditions

Original Image Documentation			
Site Name:	Dolly Sods Wilderness	Vista Reference:	Dolly Sods
Forest Reference:	Monongahela National Forest	Wilderness Reference:	Dolly Sods Wilderness
Original Image Filename:	DOSO1201611140910.jpg	Region:	Eastern
Site Abbr:	DOSO1	Region:	Eastern
Date:	11/14/2016	Time of Day:	09:00
Comments:			

Qualitative Summaries	
Scene Code:	Image Code:

US Forest Service
Air Quality Images


Pristine Conditions

Original Image Documentation			
Site Name:	Dolly Sods Wilderness	Vista Reference:	Dolly Sods
Forest Reference:	Monongahela National Forest	Wilderness Reference:	Dolly Sods Wilderness
Original Image Filename:	DOSO1201611141210.jpg	Region:	Eastern
Site Abbr:	DOSO1	Region:	Eastern
Date:	11/14/2016	Time of Day:	12:00
Comments:			

Qualitative Summaries	
Scene Code:	Image Code:



US Forest Service  
Air Quality Images



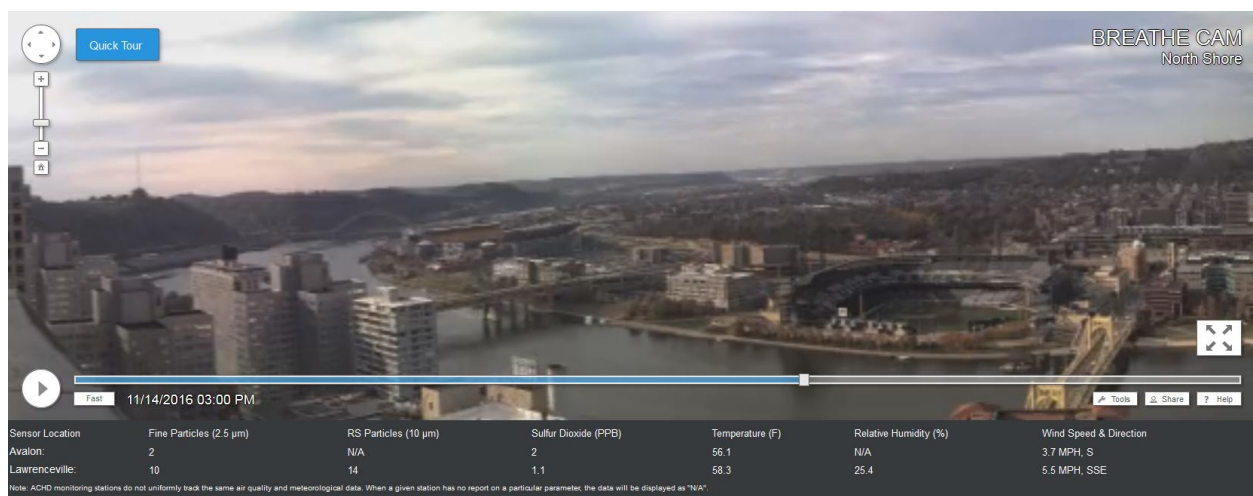
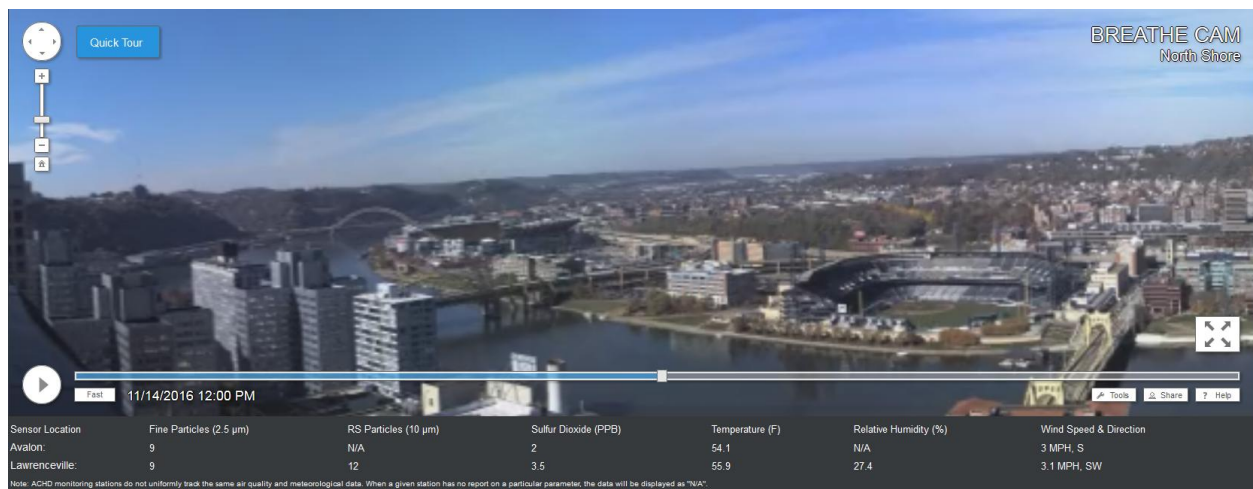
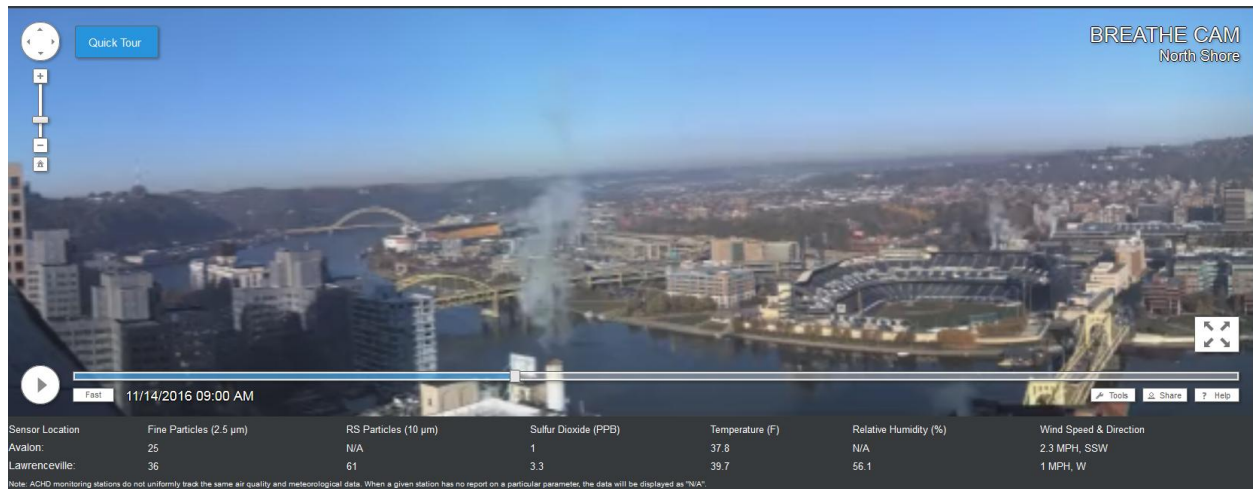



Pristine Conditions

Original Image Documentation			
Site Name:	Dolly Sods Wilderness	Vista Reference:	Dolly Sods
Forest Reference:	Monongahela National Forest	Wilderness Reference:	Dolly Sods Wilderness
Original Image Filename:	DOSO1201611141510.jpg	Region:	Eastern
Site Abbr:	DOSO1	Region:	Eastern
Date:	11/14/2016	Time of Day:	15:00
Comments:			
Qualitative Summaries			
Scene Code:		Image Code:	

Images revealed somewhat hazy conditions for transported air from the south of southwestern PA.

Below are images from the BreatheCam in downtown Pittsburgh, at the same times as Dolly Sods images. The photos show a brown haze early in the day, clearing up somewhat during the day, returning to more hazy conditions in the afternoon.

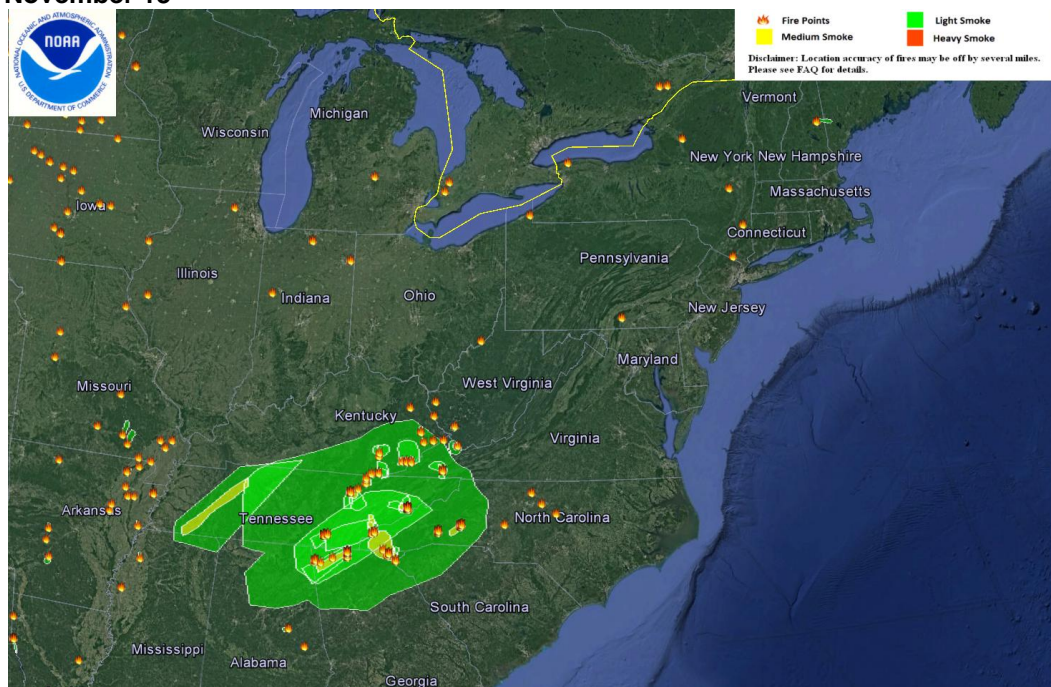




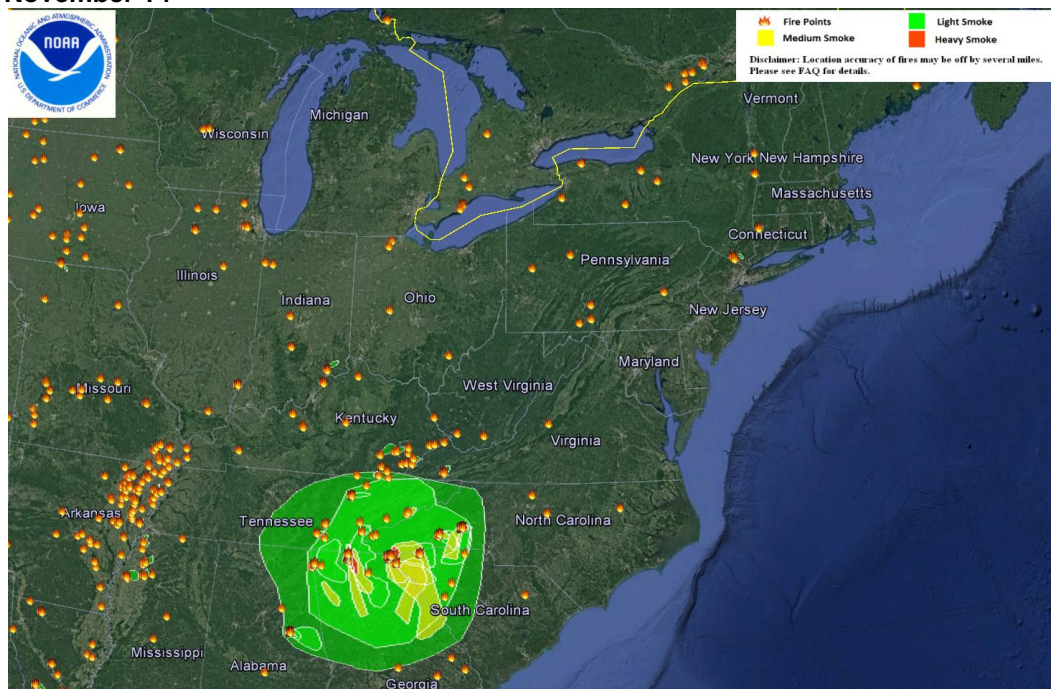
## Fire/Smoke Imagery

Below are a Google Earth plots from NOAA showing fire points and smoke for November 13<sup>th</sup>, concentrated in the North Carolina and Georgia but also present as far north as Kentucky and West Virginia, just upwind of PA.

November 13<sup>th</sup>

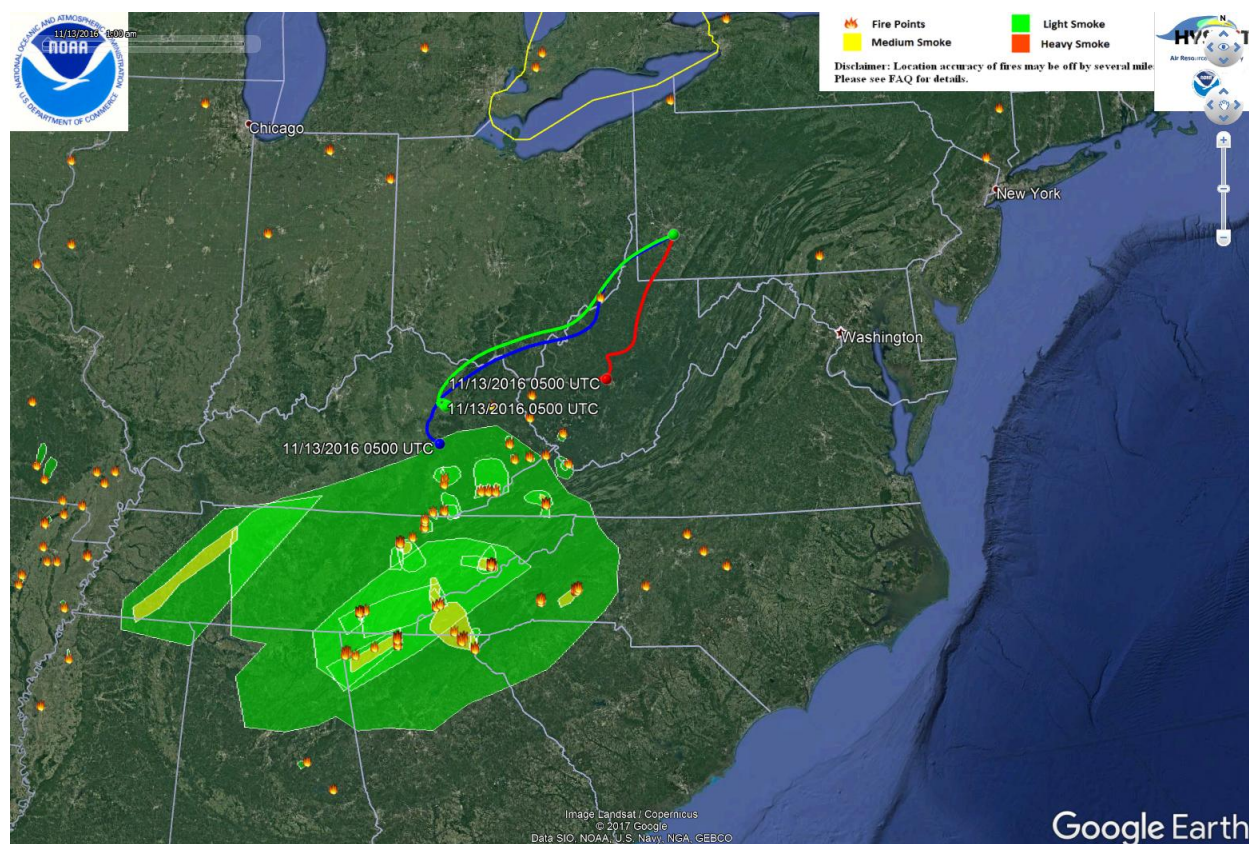


November 14<sup>th</sup>



Below are 48-hour back trajectory generated by HYSPLIT for Nov. 13-14<sup>th</sup> (5 AM UTC Nov. 13 through 5 AM Nov. 15<sup>th</sup>), along with the fire/smoke overlays in Google Earth.

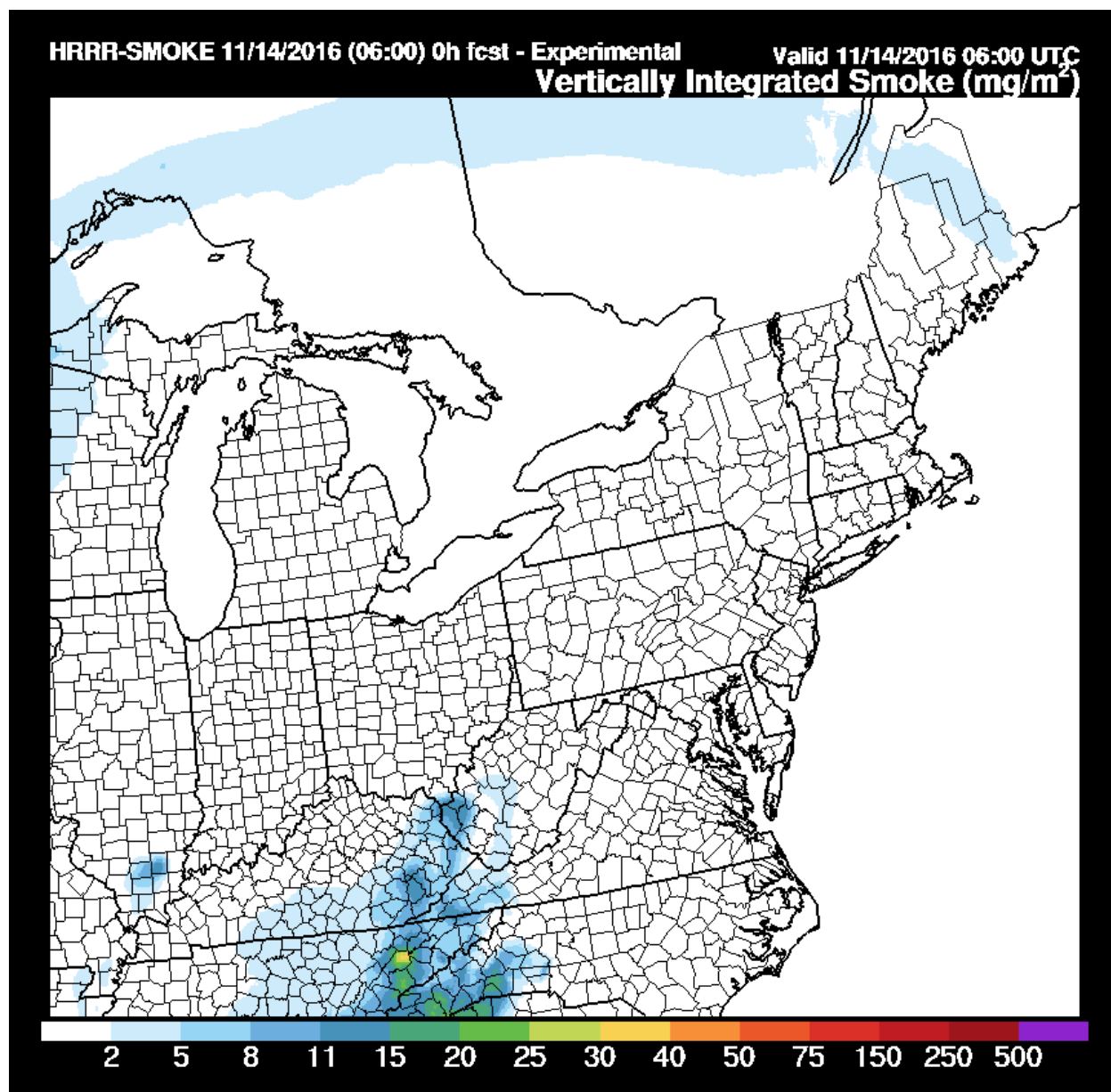
HYSPLIT back-trajectories are shown for 50 m (red), 500 m (blue), and 1500 m (green) above ground level. (GDAS0p5 meteorology was used for the plots.)



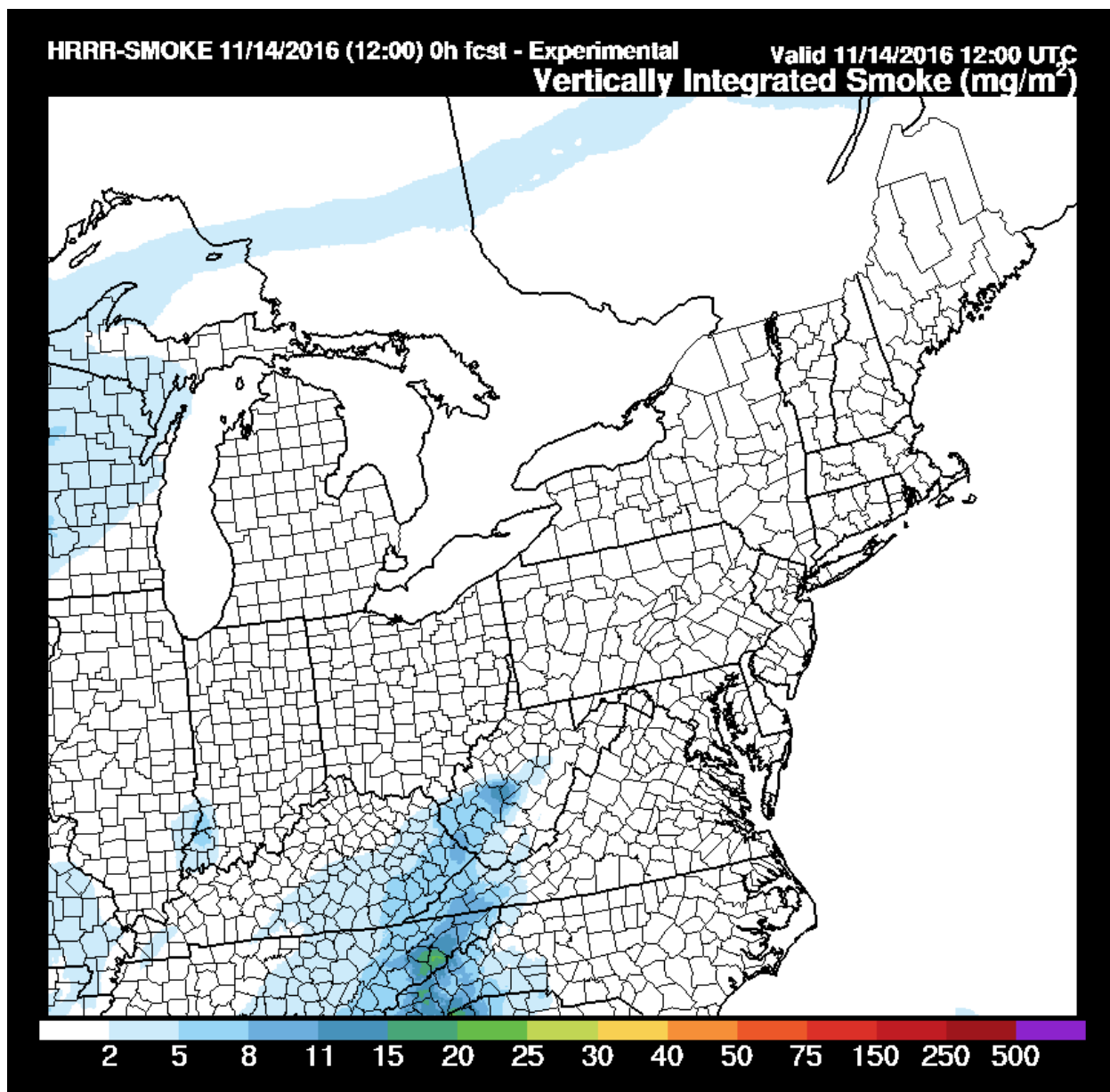


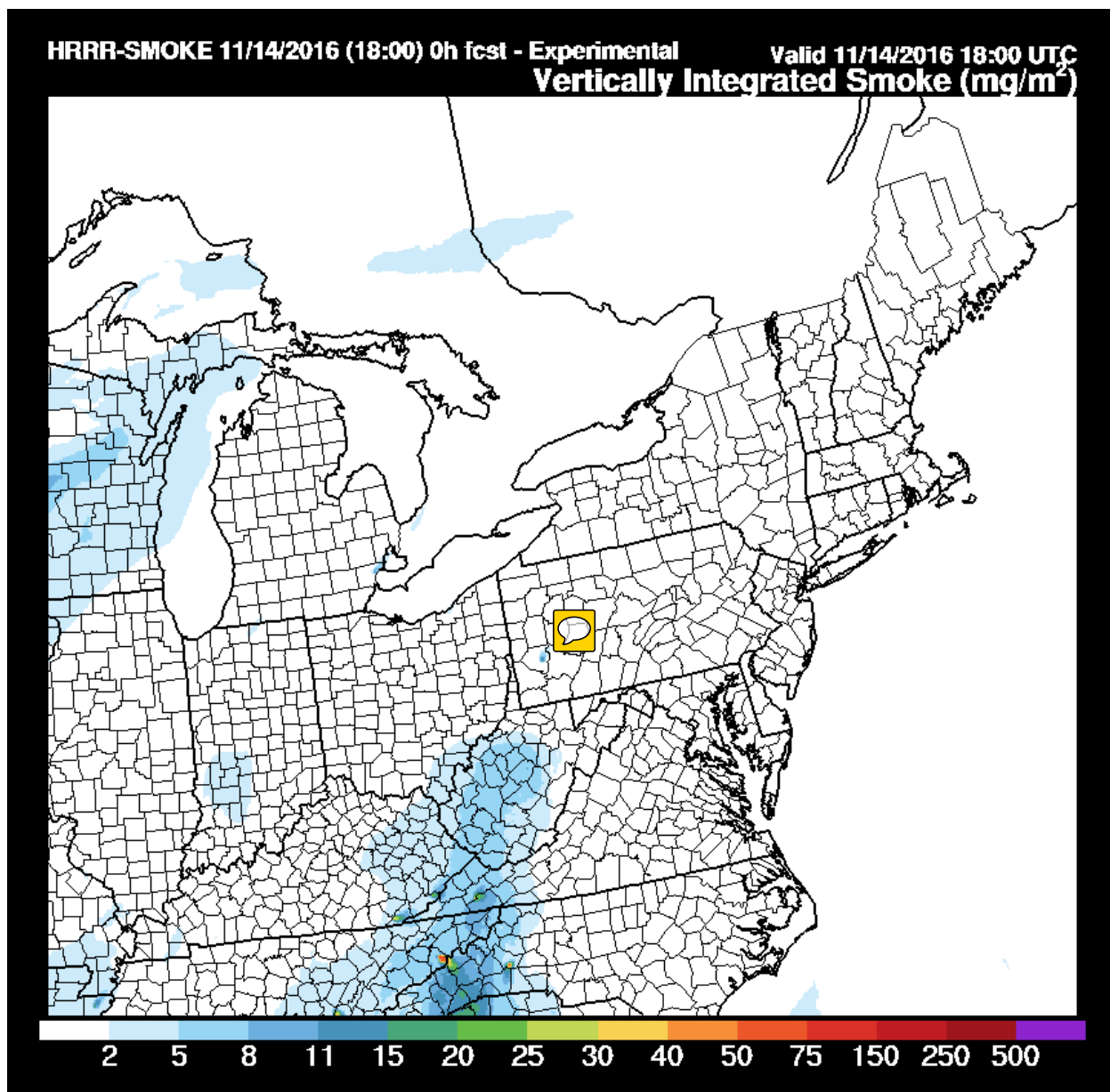
The back-trajectory plots show that visible smoke may have been directly transported into PA from at least one near-surface level (500 m). This smoke may have been further trapped in local air in Allegheny County during inversions.

Below are images for vertically integrated smoke as generated from High-Resolution Rapid Refresh (HRRR)<sup>1</sup> modeling system for Nov. 14<sup>th</sup>. (Models are restarted created every 6 hours; shown are images with beginning hours of 6 AM UTC Nov. 14<sup>th</sup> through 6 AM UTC Nov. 15<sup>th</sup> for the Northeast U.S. (NEUS).)

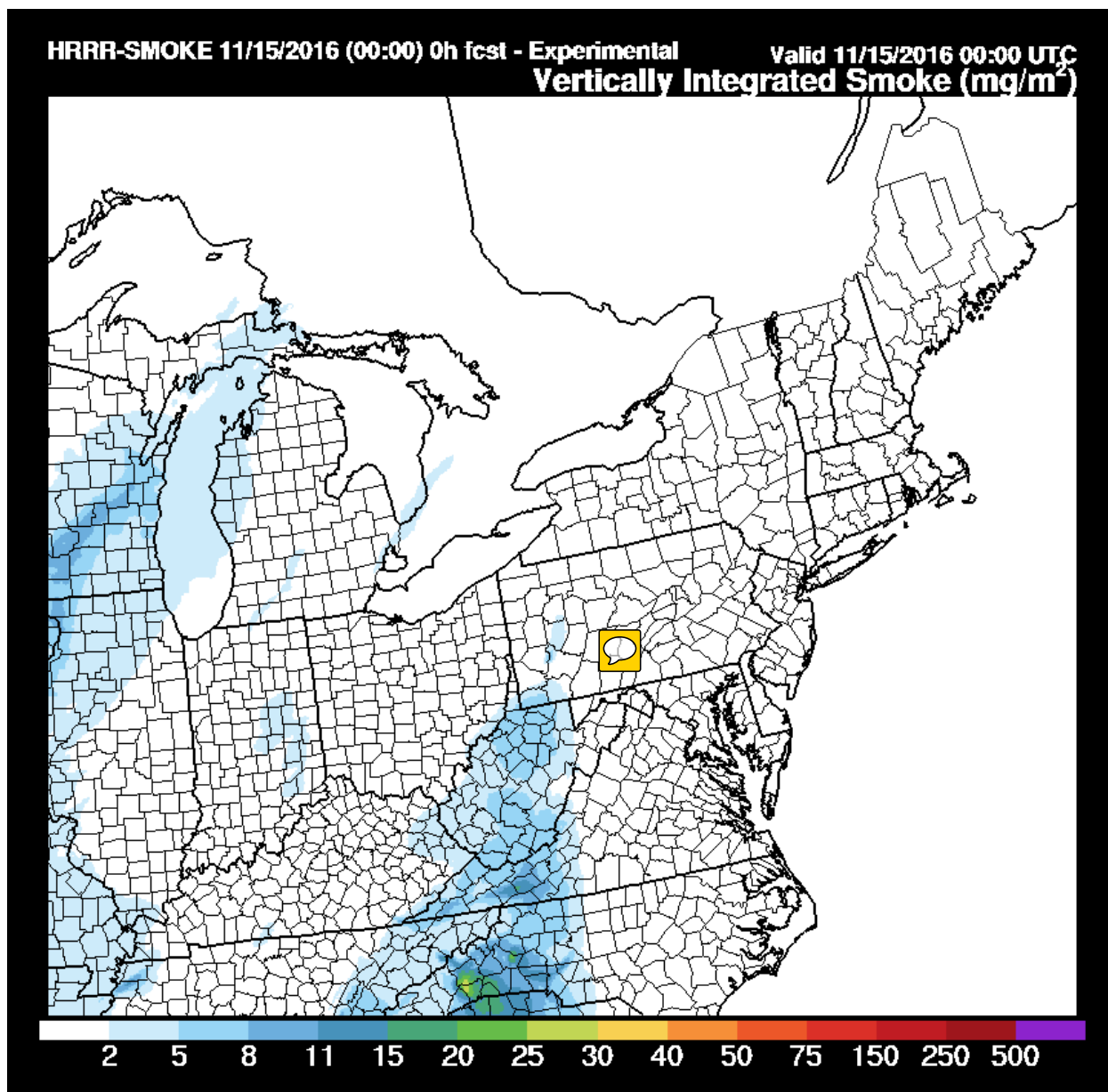


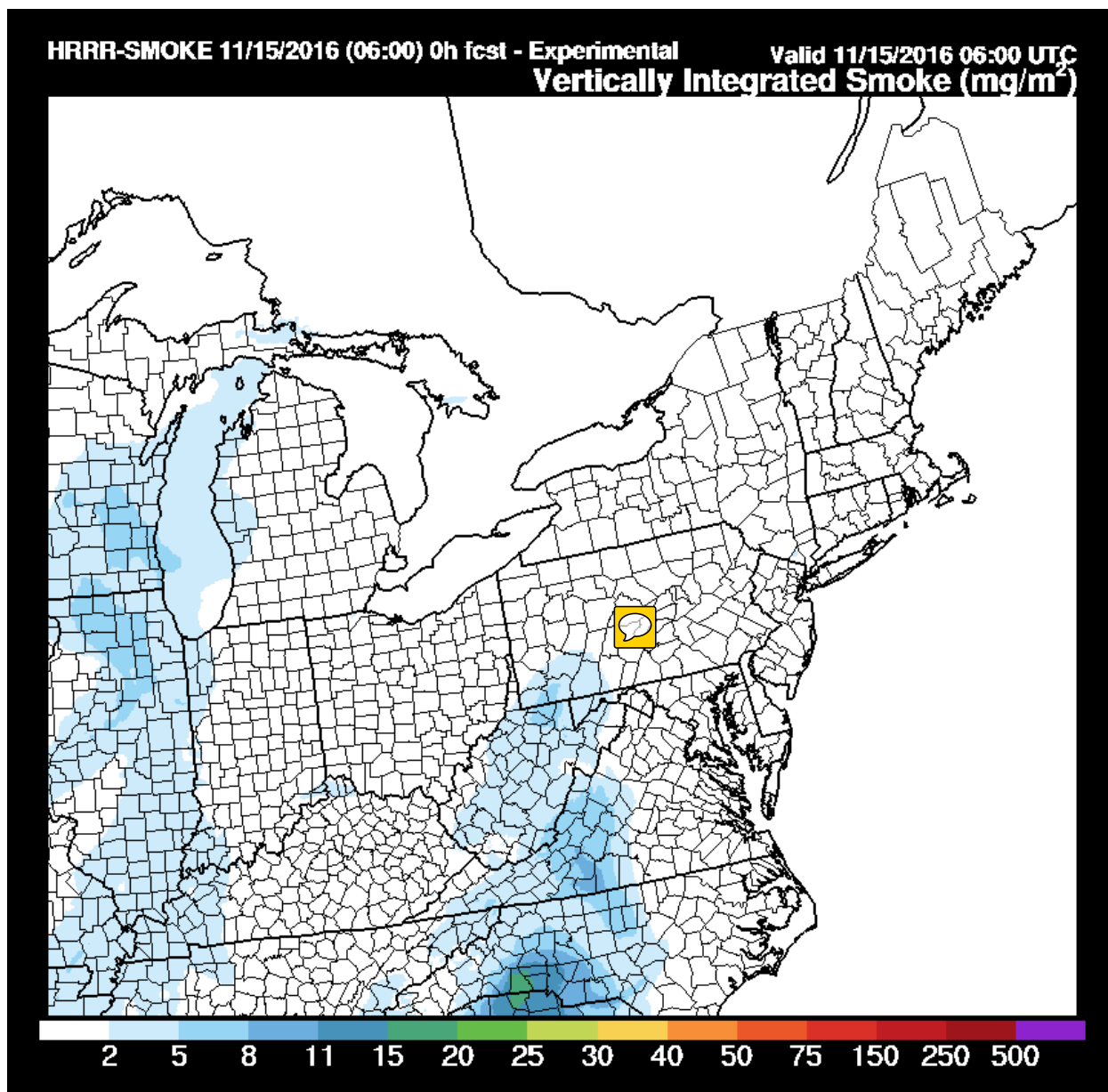
<sup>1</sup> <https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/>









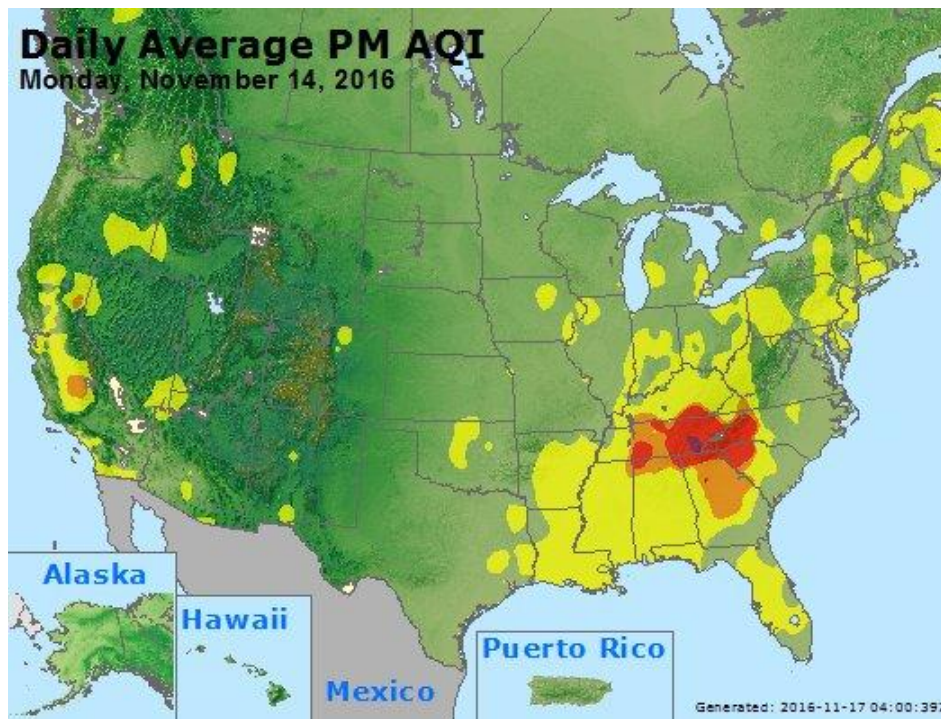
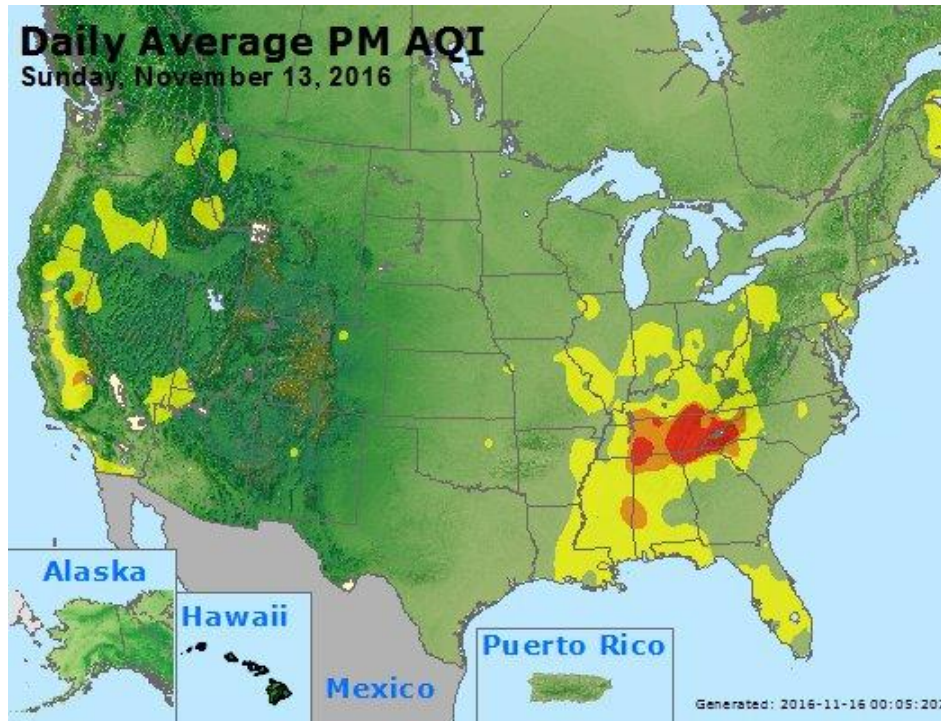


The HRRR vertically integrated smoke plots<sup>2</sup> show that smoke may have been transported from the Appalachian fires into the southern portion of Allegheny County. (The Liberty monitor is located near the southern “boot” of Allegheny County.)

<sup>2</sup> Vertically integrated fire smoke plots show simulated total PM<sub>2.5</sub> mass within vertical columns over each model grid cell (or fire smoke). These columns reach as high as ~25 km above ground. The purpose of showing such plots is to display the effect of fire smoke load which includes smoke in boundary layer as well as aloft, illustrating the integral effect of fire smoke throughout the atmosphere.

## AQI Plots

Below are daily average AQI plots for the U.S. for Nov. 13-14<sup>th</sup>. These plots show widespread PM over the 48-hour period in the moderate level. While the Liberty exceedances aren't specifically shown at this scale (would be in orange or red), the widespread values indicate regional levels that were above the good level for much of western PA.





## Conclusions

Preliminary data suggests that Appalachian wildfires may have contributed to PM<sub>2.5</sub> levels at the Liberty monitor in November 2016. (Any of above analyses included in this report can be expanded for more detail.) The exact portion of the contribution of wildfires is difficult to discern. There may be a mix of local industrial or other components, along with a regional smoke component, that cannot be pinpointed with current available data.

